Installation of Neutral Current Detectors in SNO

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The SNO experiment entered its third phase this year. The first phase of the experiment was characterized by the pure D_2O target from 2 November 1999 until 29 May 2001. In the second phase, between 26 July 2001 and 28 August 2003, we witnessed the addition of 2 tons of NaCl to the D_2O to enhance the sensitivity to Neutral Current Reactions. Subsequently, the NaCl was removed from the D_2O to a level of $\sim$few ppm. Following a careful analysis of SNO's detector response, we ensured that close to the original characteristics returned. Only then did the collaboration began to install an array of 40 discrete neutron detectors, the Neutral Current Detectors or NCD Array.

The NCD array will permit SNO to separate, event-by-event, Neutral Current (NC) from Charged Current (CC) events and significantly decrease the correlated and overall systematics associated with the determination of these solar neutrino fluxes. We anticipate two calendar years of data in this phase. At the completion we anticipate our errors on the CC flux dropping from 5.3% (systematic) for the pure D_2O phase to 3.3%, while the error on the NC flux would drop from 9.0% to 5.2%. The enhanced detection efficiency would also decrease the statistical errors for the CC (NC) from 6.3% (12.4%) for the pure D_2O phase to 4.0% (6.4%) for 365 days of NCD operation.

While we originally manufactured a large enough array of the ^{3}He tubes to produce 96 NCDs filling the D_2O volume with a 1 *m* grid of the detectors, we eventually decreased the array size to only 40 strings filling the central volume of the detector. The array configuration was optimized for neutron detection, detector optical response (the NCDs block some fraction of the light produced by CC events), radioactive backgrounds, and related detector response systematics. From the original components, an elite set of components were selected and matched for the final NCD array. To install this array, the entrance portal to the detector was deconstructed, temporary install fixtures were installed, a remotely operated submarine (ROV) was deployed in the D_2O, and overall detector cleanliness was maintained and carefully monitored. From November 2003 until April 2004 the NCDs were installed.

The installation consisted of a labor intensive process of inserting the well-characterized ^{3}He proportional tubes into the detector, hauling them down into the D_2O using ratcheted deployment mechanism, welding tube segments together, and finally deploying the array into its position using the ROV. The cables were then secured along the neck of the D_2O acrylic vessel.

All components used to fabricate the NCDs along with the fabrication and assembly processes were carefully controlled to limit possible contamination from entering the detector. Our goal was to limit backgrounds to $\sim 1\%$ of the standard solar model. The Berkeley Lab low counting facility was used to survey many components for uranium and thorium chain contamination. Extensive modeling of the array and its performance were performed on NERSC's PDF cluster. Nuclear Science Division personnel were directly involved with the NCD installation, including supervising install teams.

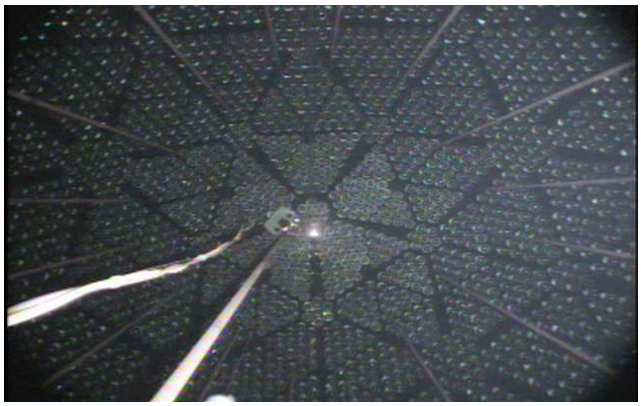

FIG. 1: This camera view is from the bottom of the AV chimney looking downwards on nearly completed array of NCD detectors installed in SNO (the gray tubes seen extending through the image). The ROV is seen near the center of the image preparing to install the closest NCD detector to its final location. The array of PMTs is visible in the background behind (and through) the Acrylic Vessel. The bottom most panel of SNO (it's South Pole) is located at the center of the image below and to the right of the ROV. The ROV's umbilical is seen to the left of the NCD, snaking down to the submarine. This umbilical supplied electricity for the propellers, lights and cameras and a compressed gas line to alter its buoyancy.

The array, having completed its final installation in April 2004, is undergoing extensive calibration and commissioning. The cleanroom above the AV neck is being reinstalled along with several improvements to related instrumentation.